

50X1-HUM

METHOD OF OBTAINING CHANNELS FOR THE TRANSMISSION  
OF TELEMECHANIC SIGNALS

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50X1-HUM

[Figures referred to herein are appended.]

10 The article describes the method of obtaining supplementary channels for the transmission of telemechanics signals, based on reducing the telephone spectrum to 1700 cycles and using higher frequencies for 2-3 telemechanics channels.

The basic norms for such channels are indicated.

The method given is recommended for application in existing systems of high-frequency communication over high-voltage lines.

Centralized control by power systems leads to the necessity of putting in practice remote control, telemetry, and remote-control signalling.

Herein, in many cases, difficulties arise in view of the necessity of obtaining channels for the transmission of telemechanics signals. The <sup>acquisition of</sup> ~~requirement~~ of additional aerial or cable circuits usually meets with great difficulties, even the use of existing channels is troublesome because of their employment by other communications.

We shall not examine all possible methods of transmitting remote-control signals over existing channels (for instance, by temporary interruption of a telephone conversation), but shall study one of the very efficient methods of obtaining continuously functioning telemechanics channels. The substance of this method is as follows.

In ordinary voice transmission, it is possible to maintain sufficient clearness of words and sentences not only of a frequency spectrum of 300 + 2400 cycles, but also of an even

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narrower frequency band. Thus for example, in the USSR, a band width of  $300 \rightarrow 2000$  cycles/<sup>second</sup> is taken as the norm in transmitting over steel circuits.

§ At present both in the USA and the USSR the "sharing" of telephone channels is extensively used in wide-band high-frequency systems with an operating spectrum of  $300 \rightarrow 3500$  cycles/<sup>second</sup>.

§ As a result of such sharing, there are obtained from one wide channel two narrow channels with an effectively transmitting frequency band of  $300 \rightarrow 1700$  cycles/<sup>second</sup>. Thereby, the quality of voice transmission is maintained on a fairly satisfactory level.

§ A similar principle may be applied to obtain supplementary channels for transmitting telemechanics signals. Leaving the frequency spectrum of  $300 \rightarrow 1700$  cycles/<sup>second</sup> for telephone transmission, it is possible to put into operation  $2-3$  telemechanics channels at frequencies up to  $2400$  cycles/<sup>second</sup>. (An example of such frequency distribution is given in Figure 1. Here the standard distribution of MKKF frequencies for sonic telegraph is <sup>t</sup>aken for <sup>to</sup> telemechanics channels. The interval between the telephone channel and the low operating frequency for telemechanics channels is equal to  $360$  cycles/<sup>second</sup> cycles and is entirely sufficient for separating them with the <sup>aid</sup> help of filters. The telemechanics channel width is taken as equalling  $80$  cycles/<sup>second</sup> corresponding to the channel width for sonic telegraphy, since the <sup>magnitude</sup> duration of telemechanics pulses are of <sup>order</sup> ~~one~~ equal order with the duration of the signals of the telegraph equipment used on the telegraph frequency.

§ A skeleton plan of the equipment for the inclusion of telemechanics channels is shown in Figure 2.

§ In this case, direct connection is broken between the differential system and the transmitter and receiver of the telephone channel (for example, of a high-frequency station), that is, the normally connected points A and B ~~and~~, correspondingly, A' and B'

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are disconnected. Between these points chokes and capacitor filters are switched in (filters of low and high frequency), serving to divide telephone and telemechanics signals.

§ The attenuation of capacitor filters in the filter attenuation band cannot be large, since the main burden of shielding the telemechanics channels from interference on the part of the telephone channels rests upon the narrow-band filters.

§ Telemechanics channel receivers and transmitters are of a construction similar to that of like equipment for sonic telegraph installations; the transmitters consist mainly of carrier frequency oscillators, of band filters and relays controlling the sending of signals; the receivers consist of receiving filters, amplifiers and rectifiers, and receiving relays.

§ In addition, general amplifiers are needed to secure the proper levels for transmitting and receiving. It is also necessary to have in the amplifiers, or separate from them, leveling circuits to compensate for disproportionalities in the residual attenuation of the telephone channel in the spectrum of 2000 - 2400 cycles <sup>1</sup> and also in the condenser filters.

§ Let us now examine the permissible levels of transmission and reception.

§ The level of a transmission for telemechanics channels, referring to a point with a relative zero level, can be determined according to MKKF norms by the formula:

$$P_f = 0.8 - \ln n$$

§ Here  $n$  (the number of channels) must be considered equal to 12-18, since, although there are in all 3 telemechanics channels, the role of the remaining telemechanics channels in relation to the load of the whole channel is played by telephone conversation. Therefore, the level in a given case will be of the order of

$$P_f = 0.8 - \ln n \approx 1.7 \text{ neper (unit of attenuation).}$$

-3-  
NOTE: space gap

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The effective level of transmission at the point of connection with the telemechanics channels (point B, Figure 2) will equal

$$P_f' = P_f - b,$$

where  $b$  is the attenuation of the differential system.

It is necessary to observe that, in preventing overloading of the channel and harmful interference from such overloading with the work of the telemechanics channels, it is necessary to include a regulator for the telephone conversation voltage in the telephone channel (point A, Figure 2).

The level of telemechanics channel reception at point B' (Figure 2) can be determined in the following manner:

$$P_f = P_f' - b_r + b',$$

where  $b$  is the residual attenuation of the channel at the working frequencies of telemechanics channels, and  $b'$  is the attenuation of the differential system in the direction of reception.

Attenuation  $b_r$  for the higher frequencies of the telephone spectrum at which the telemechanics channels operate can be of the order 1.5-1.8<sup>8</sup> neper.

Attenuation of the differential system  $b \approx b' \approx 0.5$  neper. mind p. 138

Consequently, the magnitude of the receiving level can be determined.

Let us now examine the question of a call system when the method under consideration is used to obtain telemechanics channels.

As we know, in many systems of high-frequency stations operating over high-voltage lines, and also in many high-frequency systems operating over ordinary communications lines (for example, SMT-34), sending a telephone call is effected by shutting off admission of the carrier frequency to the line.

In some systems of high-frequency stations, the call is based on a change of the carrier frequency of the transmitter (Siemens and Halske single-band system). It is quite obvious that it is impossible to maintain such call systems when supplementary channels

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for telemechanics are superimposed, since in sending a call the work of these additional channels would be disrupted. Hence it is necessary to apply a sonic call system. Moreover, if all telephone calls through a high-frequency station are made from equipment directly connected with the station, there is no necessity for providing special protection for the sonic call receiver from deterioration which might be generated by telephonic currents. (In this system it is possible to create a design wherein the sonic call receiver will be connected with the channel only at the time conversation is not being carried.

But if the high-frequency station is connected with a switchboard, it is necessary to employ a sonic call system with protection against deterioration.

There are a great many such systems with sufficiently reliable protection, and any of them may be applied.

Thus, the additional equipment for obtaining 3 channels for transmission of telemechanics signals must consist of receiver-transmitter equipment and separating filters, as shown in Figure 2, and also of tonal call equipment.

The advantage of such a system for the separation of telemechanics channels consists in the fact that they can be obtained on any sonic frequency channel operating on physical or electrical four-conductor circuits. In this connection it may be pointed out that the utilization of the infrasonic frequency spectrum of high-frequency channels is less desirable since it is subject in a greater degree to interference from outside factors during carrier frequency modulation.

Practical production of such apparatus and its rapid introduction will permit a radical solution to the problem of channels for transmission of telemechanics signals without appreciable deterioration in the quality of telephonic transmission.

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5 In 1944 the Institute of Automatics and Telemechanics, (USSR Academy of Sciences, in collaboration with the Moscow Power Station, carried on research work on the possibility of adding supplementary channels, since it could be shown that, <sup>despite</sup> ~~in spite of~~ the possibility of such an addition in principle, in many cases the frequency and other characteristics of the residual channel attenuation cannot satisfy the necessary conditions.

5 Surveys were made on the Moscow-Uglich sector.

As a consequence of the surveys, it was established that the basic characteristics of a high-frequency channel with reference to the noise level and nonlinear distortions were sufficiently satisfactory.

5 It should be noted that it is precisely these characteristics which are most essential, as their correction and improvement are practically impossible without completely redesigning the apparatus.

5 There was some variance with technical requirements in regard to the frequency characteristic of the residual attenuation, which was explained by the circuit disturbance of the transmitter and receiver, and also by the presence of additional circuits in the filter on the connections, which separate the telephone station from the shielding station.

5 The frequency characteristics of the residual attenuation may be improved without great expense either by appropriate arrangement of the circuits or by the addition of a special equalizing circuit, such as was specified in the planning of equipment for obtaining additional communication channels, <sup>developed</sup> ~~worked out~~ by the Institute of Automatics and Telemechanics, (USSR Academy of Sciences. It must be noted that equalization of the frequency characteristic of the residual attenuation may be carried out when there is considerable disproportionality of the characteristics, so that the addition of supplementary channels may be affected also when there

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are one or two relay points.

A detailed description of the principle of the plan <sup>developed</sup> ~~marked out~~ by the Institute of Automatics and Telemechanics, USSR Academy of Sciences, electrical data on it, and possible structural formation is not given in this article.

It must be noted that it is advisable to make such a reduction in a telephone channel only in high-frequency communication systems already in existence. In the recently planned systems, it is advisable to employ the normal telephone channel width, and to utilize telemechanic channels in the supersonic spectrum. (See the author's article in the <sup>periodic</sup> "Avtomatika i Telemekhanika" journal, number 1, (1946).)

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[appended figures follow]

**CONFIDENTIAL**

*1499  
P. 137  
P. 138*

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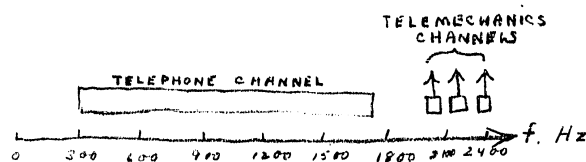


FIGURE 1

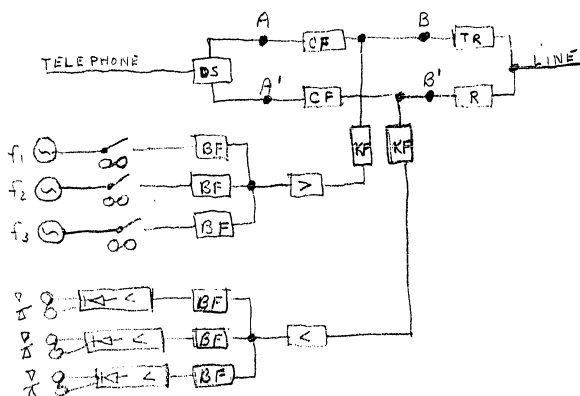


Figure 2

**KEY**

DS- DIFFERENTIAL SYSTEM  
CF- CHOKER FILTER  
KF- CAPACITOR FILTER  
TR- TRANSMITTER  
R- RELAY  
BF- BAND FILTER

*without base case?  
P. 137*

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